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Discussion of increasing enrollments in mathematics courses; problems connected with graduate courses; and effect of shortage of senior staff on undergraduate teaching, graduate study, and research. Statistics on past and future enrollments and history of teaching staff in mathematics. Summary of present and future staff needs and of future teaching of mathematics courses at all levels.

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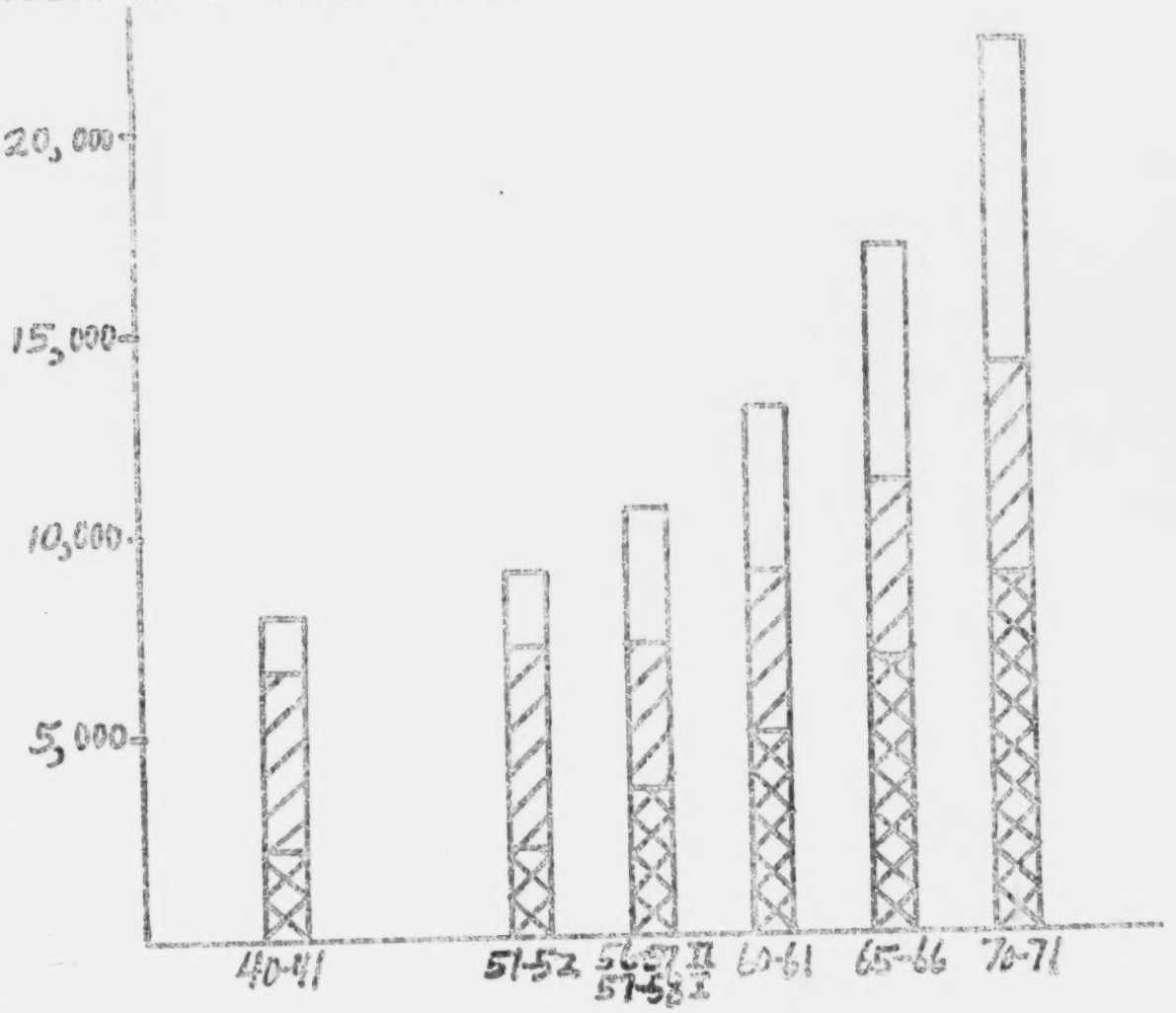
IV-5 (Science)

MATHEMATICS AT THE UNIVERSITY OF WISCONSIN (MADISON) PRESENT AND FUTURE[1]

IV-5 (Journal)

The Department of Mathematics is now seriously understaffed at the senior levels (Instructors, Assistant Professors, Associate Professors and Professors).

On the one hand, enrollments in mathematics have sharply increased. The University itself has grown, and the increased importance of mathematics in science, industry and government has led students to take more of their work in mathematics. The trend of mathematics enrollment is shown in Chart 1.[2] We compare it with enrollment in the Colleges of Letters and Science and of Engineering, which together furnish most of the undergraduate mathematics students. From 1951 to 1957 the total enrollment in these two Colleges increased 17%, the enrollment in Letters and Science very little, and the enrollment in mathematics courses 68%. The new regulations of the College of Engineering, which will not be fully effective until 1960, will further increase the demands upon the Department of Mathematics. There is every reason to believe that the University will continue to grow, and that the proportion of mathematics courses elected by students will continue to rise. In Chart 1 we have included an estimate of future mathematics enrollment which seems conservative.



Enrollment in Letters and Science and Engineering
Enrollment in Letters and Science
Enrollment in Mathematics Courses

Chart 1.

[1] A report of the Department of Mathematics (Madison), March 4, 1958. It is part of a more comprehensive report dealing with the statewide situatio

[2] The statistical material on which the charts and estimates are based forms the second part of this report.

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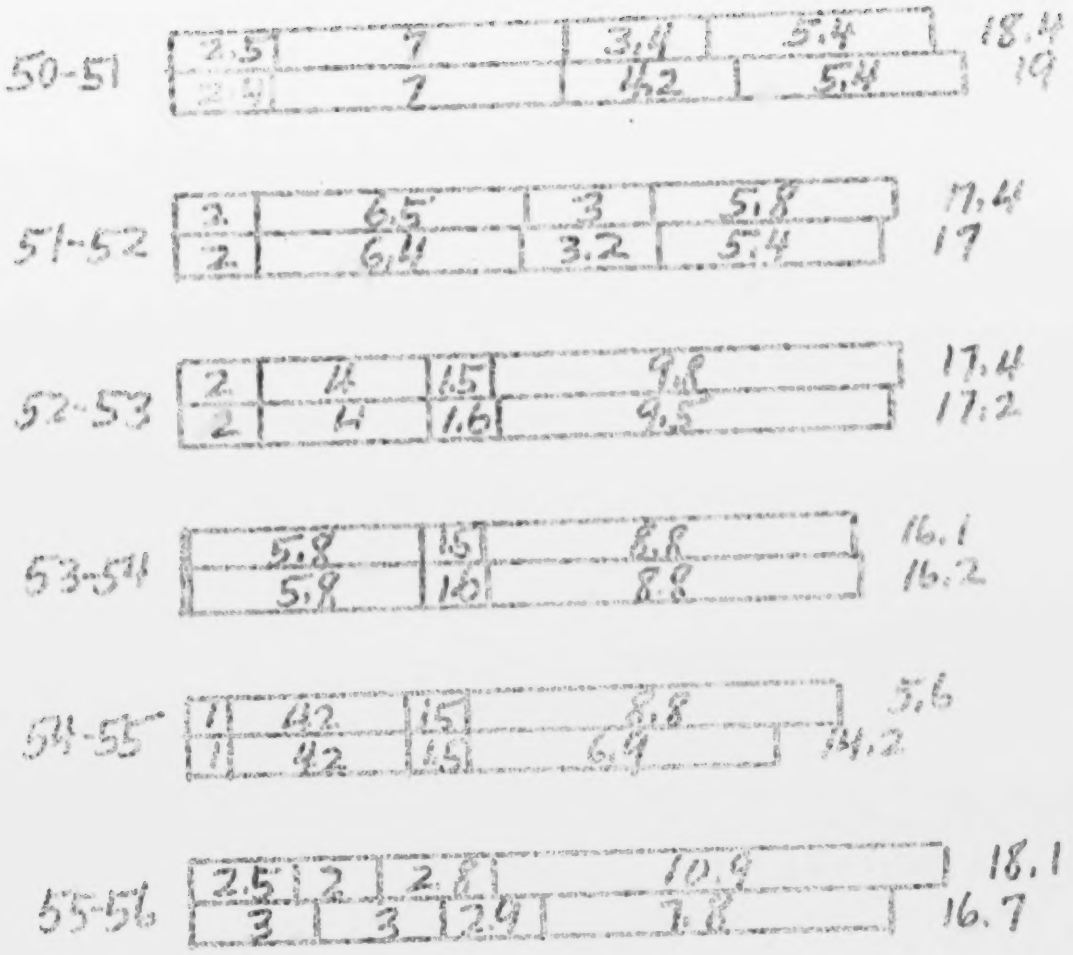

Mathematics Department - University of Wisconsin

Instructors - Assistant Professors - Associate Professors - Professors

Nominal
Actual

Chart 2

On the other hand, the senior staff of the Mathematics Department has from 1951 to 1957 suffered a slight decline in its number. This is shown in Chart 2. The upper row of blocks for each academic year shows the numbers of persons at each of the four senior levels who are "nominally" carried on the Department of Mathematics Academic Budget, and the lower row the numbers "actually" carried on this Budget.[3]

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[3]Persons are counted only to the part of their salary paid under this Budget. For example, Professor A who is regularly 50% on Mathematics Academic Budget and 50% on the budget of the Numerical Analysis Laboratory counts 0.5 in each row if on duty. Professor B, ordinarily full time on the Mathematics Academic Budget but temporarily devoting 30% of his time (budgetwise) to a

So far the most serious effect of the shortage in the senior staff has been the placing of almost all freshman and sophomore classes, even those in the calculus, in the hands of teaching assistants. In 1957-58 I, out of 118 sections in courses through the first year of calculus (Courses 102b and below), only 7 were taught by senior staff (specifically, 5 by Instructors and 2 by Assistant Professors).

The Department of Mathematics has given much thought to the problems of how to remedy the current situation and of how to meet the even more critical one which appears to be impending in the estimated mathematics enrollment for 1960-61, for 1965-66 and for 1970-71. It has studied two plans. Plan A, which is preferable from the standpoint of effective teaching, is essentially a continuation of the traditional system with classes limited to about 30 students and with at least 50% of the calculus sections taught by senior staff members. Plan B calls for large lecture classes in calculus, differential equations, and other 100 level courses having large registrations.

We are now ostensibly on Plan A, but as indicated it is not functioning properly. To restore Plan A to effective functioning now would require an immediate increase in the senior staff from the present "actual" 14.7 under the Academic Budget to an "actual" 23. The continuation of Plan A into the future would require an increase to an "actual" 34 in 1960, to 45 in 1965, and to 59 in 1970. The present number of teaching assistants would have to be doubled to 140 by 1970.

For Plan B the senior staff would have to be increased, not quite so drastically, to an "actual" 24 by 1960, to 31 by 1965, and to 39 by 1970.[4] The number of teaching assistants would have to be increased, even more, to 160 by 1970. Intensive use of Plan B will be impossible until about 1960. because of a shortage of large classrooms.

Thus far this report has dealt with the effect of the shortage of senior staff on undergraduate teaching. A second major function of the Department of Mathematics is graduate teaching and research.[5]

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research contract counts 1.0 in the upper row and 0.7 in the lower. Professor C, a full time appointee on Mathematics Academic but on leave for the year, counts 1.0 in the upper row and 0.0 in the lower. Visiting Lecturer D teaching full time counts 0.0 in the upper and 1.0 in the lower. A third figure, the "catalog" size of the senior staff (24 in 1957-58), is obtained by counting each person who holds an appointment in Mathematics as 1.0, irrespective of the part of his time he devotes to it.

[4] Currently 20 members of the Mathematics Department on the "catalog" basis[3] devote the major part of their time to Mathematics and have their principal office in its building. Applying the same ratio (20/14.7 = 1.36) to the estimated "actual" 59 under Plan A (or 39 under Plan B) in 1970, the Mathematics Department must "house" 80 (or 53) senior staff members in 1970.

[5] A third major function (not sharply separated except in budgeting from the research aspect of the second function) is the performance of mathematical services to the University. It operates the Numerical Analysis Laboratory, is associated with the Mathematics Research Center United States Army, and does work under contracts placed by governmental agencies with the University. The part of the staff budgeted for these services is left out of Chart 2 (as was explained in Footnote 3).

It is from the students proceeding to the M.A. or M.S. degree in mathematics, and the smaller but even more important group proceeding to the Ph.D. degree, and similar groups in other United States universities, that the urgent needs for well-trained mathematicians in industry and government, and in high school and college teaching, must be supplied. In the present scientific and educational crisis, the progress and even the survival of the nation depend on maintaining and augmenting its mathematical manpower.

Chart 3 shows for recent years the number of graduate students in mathematics at the University of Wisconsin (Madison).[6] In the five years

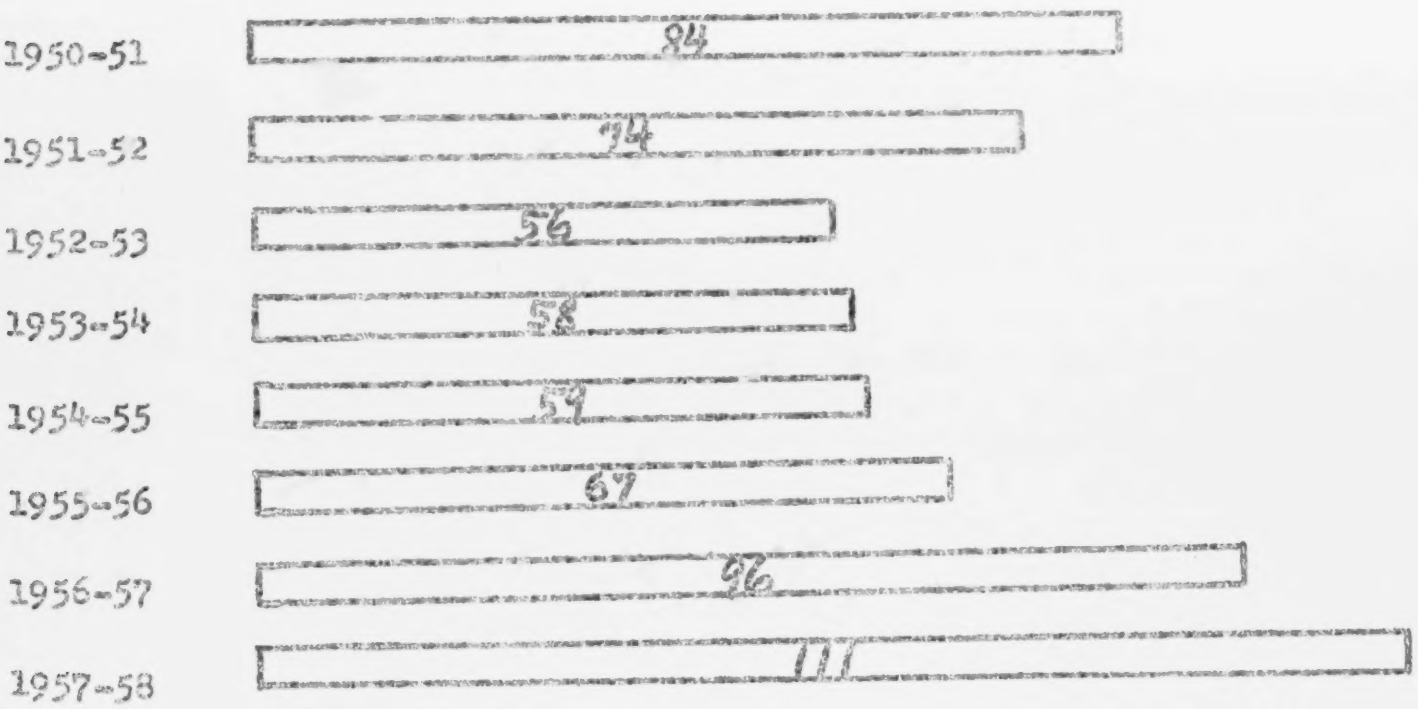

Chart 3. Graduate Students in Mathematics at UW (Madison).

1952-53 through 1956-57 the Department turned out an average of 5 Ph.D.'s per year (out of approximately 250 per year in the nation), and it will do about the same in 1957-58. The number of master's degrees has doubled in the last five years; 32 were awarded in 1956-57. Without a strengthening of the senior staff at its upper levels no substantial increase in the rate of production of Ph.D.'s can take place, because direction of theses requires individual attention by staff members themselves active in research.

The senior staffs of mathematics departments not only are responsible for graduate mathematical education, but also constitute the main group on which the nation depends for its current basic research in mathematics, and one of its principal mainstays (mathematicians in industry and government being the others) for its applied mathematical research. Research, both basic and applied, carried on in mathematics departments is in considerable measure subsidized by government contracts. But the universities must staff the mathematicians who can do the research, and indeed to greater numbers than would be required for the teaching functions alone.[5]

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[6]The classes taken by these students are included in Chart 1.

Research by members of the Mathematics Department at Madison is internationally recognized. This would hardly be an appropriate time for the State, through its University, to decrease its share in supporting graduate education and research. Moreover, it could not do so without inviting a further deterioration in the undergraduate teaching of mathematics. The functions of the Department in undergraduate teaching and in graduate teaching and research are linked by the use in the former of teaching assistants who are graduate students. If the University does not continue to maintain broad offerings of graduate courses in mathematics, and above all a senior staff adequate to take on for thesis work those students qualified to work for the Ph.D., it will lose its reputation as a good place for graduate work in mathematics. The quality of the graduate students, which it will need to attract in increasing numbers to use as teaching assistants, will then fall.

Besides having to handle its own graduate students the Department of Mathematics is faced with a considerable demand for courses designed to fit the needs of graduate students in other parts of the University, notably Engineering, Physics and Chemistry. There is a great shortage throughout the country of people with advanced training in applied mathematics. For these reasons the Department feels that it is of great importance to increase substantially its graduate offerings in the field of applied mathematics. This heading includes special subjects (operations research, potential theory, fluid mechanics, elasticity, optics and electromagnetic theory) as well as a great variety of courses in methods and techniques (probability, tensor analysis, ordinary and partial differential equations, integral equations, calculus of variations, integral transformations, special functions). It is estimated that 3 or 4 courses above the present number will be required each semester for a satisfactory applied mathematics program. For these courses additional specialized staff is needed. However, the presence on the campus of the Mathematical Research Center U. S. Army will make it easier to attract qualified staff, and it is expected that courses and lectures given by Visiting Professors in this Center will round off the applied mathematics program.

Two fields which come under applied mathematics, broadly interpreted, call for special comment.[7] The University of Wisconsin made an early start in teaching the operation of computing machines (numerical analysis) and has been a leader in this branch of mathematics. But the demand for personnel trained in this field, and the role of numerical analysis in the research of the University, are growing so rapidly that expansion of our laboratory (staff and machine equipment) is indicated.

For a dozen years the University of Wisconsin has been planning a Department of Statistics. It has been suggested that this be an autonomous department of the University in the College of Letters and Science, but that its permanent members hold joint appointments in other departments. It was planned to have as chairman of this department a mathematical statistician of recognized standing who would also be Professor of Mathematics. Other members of the permanent staff could hold joint appointments in such departments as Education, Psychology, Soils, Economics, Sociology, and Commerce. At present the University of Wisconsin is not competent to give

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[7] A third field is actuarial science. There is an acute shortage of mathematicians available to private and governmental insurance organizations. The University has an actuarial science program under which two courses are currectly offered in each of Commerce and Mathematics.

the doctorate in statistics and thus lags behind other universities of comparable standing.[8]

The conditions which create the need for increasing the senior staff in mathematics are part of a nation wide situation. This complicates our our problem. In the present crisis in education, the law of supply and demand makes it inevitable that members of the teaching profession will recoup part of the loss in economic status which they have been suffering since 1940 relative to other groups in the economy. This will not be unjust, but by the same law the pace for rises in teaching salaries will tend to be set where the shortages of staff are the most acute, as in the teaching of science generally and particularly of mathematics and the physical sciences.

The present senior staff in mathematics, though inadequate in size, is of superior quality. This exposes it to offers from outside.[9] If the University and the State are not alert to the special danger affecting the Mathematics Department and no doubt certain other departments, they could rapidly become the least well protected.

The data in this report argue the urgency of building up the senior staff of the Mathematics Department, and here we are discussing the danger that without strong support it cannot even be held where it is. To build it up, still stronger support will be necessary. Confidence within the present senior staff that the need will be recognized and the support will be forthcoming, and some instances of support already provided, have been factors thus far in holding the present staff together.

Not only the amount of budgetary support but also its timing will be important. Mathematicians, of the caliber required to increase the size of our Department without diluting its quality, will not be easy to obtain. For such mathematicians will not be available in sufficient numbers to meet the demands throughout the nation in the next decade and more. A competitive advantage will go to those institutions which can act promptly to recruit talented mathematicians when opportunities arise.[10]

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[8] Attempts have been made to obtain a first-rate statistician in the Mathematics Department. In 1956 John Wishart of Cambridge University agreed to come to Madison for at least a year, but lost his life a few months before he was to assume his duties here. At the present moment negotiations which were opened two months ago with an outstanding statistician to join the Mathematics Department and organize a Department of Statistics are stalled over the lack of budgetary provision for a Statistics Department. The plan for forming a Statistics Department has been endorsed by a group of 31 faculty members (outside the Mathematics Department) from the Colleges of Letters and Science, Engineering, and Agriculture, and the Schools of Education, Commerce, and Medicine.

[9] This can be documented by data on the salary differentials which have been offered to members of the Mathematics Department to move to other institutions.

[10] The University of Wisconsin is at a competitive disadvantage in its rate of pay for summer contracts or teaching. Out of 21 leading universities represented at a conference for which we have data, 13 pay for summer at the maximum rate of 1/3 of academic year salary, 6 at the rate of 2/9, and only 2 (Wisconsin and one other) at the rate of 2/10.

Mathematics at the University of Wisconsin (Madison)

Part II. Statistics and Projections.

November 1957

Summary: future enrollments in mathematics courses

Predicted enrollments in mathematics courses

year	total students in L. & S. and Engineering /100	total enr. in math. courses /100	total in elem. math. (incl. 111) /100	total in 100 level math. /100	total in 200 level math. /100
40-41	80	24 18	21 16	1 1	1 1
51-52*	90	24 19	19 15	2.5 3	2 1.5
57-58, I * 56-57, II *	106	40 32	33 26	4.5 4	2.5 2
60-61	130**	54 45	45 35	6 6.5	3.5 3
65-66	170 **	73 61	60 48	8.5 9	4.5 3.5
70-71	220 **	96 81	79 63	11.5 12.5	5.5 5

*51-52 was chosen rather that 50-51 since it was the year with the lowest mathematics enrollment since 1946. The figures of 57-58, I and 56-57, II were chosen as the most recent data available.

Detailed motivations for the above predictions may be found on pages 15, 17, 19. The ** figures are based on projections made by Dr. L. J. Lins for the years 61-62 and 66-67.

University of Wisconsin
Madison

Summary: the future teaching of the mathematics courses

The present situation is unsatisfactory: there is too little senior staff participation at the lower levels, and we have insufficient staff for the more advanced courses for Engineering students. In the elementary courses the situation is particularly alarming: a student who takes fewer than five semesters of mathematics very likely never sees a senior staff member in his mathematics courses. It is desirable that every student in calculus be taught by a senior staff member at least once, and as early in the sequence as possible.

Either of the two plans outlined below will do much to improve the situation.

Plan A. All courses are to be taught in relatively small sections as at present. This means sections of average size 25 students in courses below Math. 200, average size 20 (in 1960) to 23 (in 1970) in courses above Math. 200.

Teaching assistants will teach everything below Math. 100 which is not Calculus, and they will teach half of the Calculus.

Senior staff will teach half of the Calculus and everything above Math. 102.

Roughly speaking plan A corresponds to the actual situation as it existed in the years 1951-54. In 1957 the situation has deteriorated to the point where only 13 of the 100 Calculus sections are taught by senior staff (figures for 56-57,II and 57-58,I; page 11).

Plan B. Under this plan there will be maximal use of a lecture - discussion system in calculus, differential equations and some other 100 level courses where the system is feasible. The other courses will be taught as in plan A.

The lecture - discussion system means that senior staff lectures 3 or 2 hours per week to groups of 60 to 150 students. Teaching assistants then meet the same students 2 hours per week, in discussion and problem sections of at most 25 students.

University of Wisconsin
Madison

The teaching of the mathematics courses

year	total enr. in math. /100	The past, the present and plan A for the future: ten. asst. sections	The past, the present and plan A for the future: senior staff sections	Plan B (future): ten. asst. sections (in 4 or 5 hr units)	Plan B (future): total senior staff classes (lecture classes in parentheses)
40-41	24 18	30* 10*	60* 60*		
51-52	24 19	58 46	48 46		
55-56	34 28	85 69	43 43		
57-58, I 56-57, II	40 32	112**/94*** 85**/68***	45**/71*** 40**/60***	100*** 70***	47(16)*** 42(16)***
60-61	54 45	120 90	102 92	135 100	63(28) 60(26)
65-66	73 61	160 120	136 124	180 135	80(39) 75(37)
70-71	96 81	210 160	175 167	240 180	100(51) 97(49)

*These are estimates. The figure 60 actually includes about 8 large lecture groups.

**Actual figures in 57-58, I and 56-57, II.

***Hypothetical figures indicating what plan A and B would mean today.

University of Wisconsin
Madison

Summary: present and future staff needs

year	Staff required under plan A		Staff required under plan B	
	senior staff	tea. asst.	senior staff	tea. asst.
57-58	24(15*)	62(73*)	18(15*)	66(73*)
60-61	34	80	24	90
65-66	45	115	31	120
70-71	59	140	39	160

The above figures are based on the statistics on page 9.

The numbers given for the senior staff are the numbers as they will be carried on the Mathematics (Teaching) Budget. In other words, they are based on the assumption that every senior staff member teach full time. Thus under plan A the number of senior staff is simply one-third of the number of classes (page 9). The figure given under plan B is one-third the number of classes plus 10 percent. It is felt that some cushion (such as 10 percent) is necessary because plan B could never be realized completely.

The estimates for the numbers of teaching assistants are based on the assumption of an average teaching load of 1.5 classes during the first semester.

Distribution of staff. By 1970 about 70 percent of our enrollment in 100 and 200 courses (except Math. 111) will be in the fields of analysis, applied mathematics, numberical analysis and probability and statistics. The composition of our staff should reflect this development to some extent. Already at present there is a lack of people in the areas mentioned in our Department. Failure to correct the situation will lead to justified demands by other Departments, notably in Engineering, that they be given permission to teach advanced courses which rightfully belong in the Mathematics Department.

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*The numbers in parentheses are the actual figures today.

University of Wisconsin
Madison

Past enrollments in elementary mathematics courses

year	total undergrad. students in L. & S. and Eng. /100	over-all total in elementary mathematics /100	total in courses below 100 except calculus /100	total in calculus /100	total in diff. eq. math. 111 /100	total sections	fraction of calc. taught by senior staff
40-41	72	21 16	15 8	6 8	- -		
47-48	117	37 23	18 10	18 12	1 1		
48-49	109	25 18	16 10	9 8	1 .5	118 89	
49-50	97	23 17	15 10	7 7	1 .5	104 86	
50-51	80	20 15	14 10	5 5	.5 .5	97 71	
51-52	70	19 15	12 8	7 7	1 1	83 64	18/32 14/30
52-53	70	22 18	14 10	7 8	.5 .5	88 71	16/28 13/30
53-54	72	24 20	15 10	8 9	1 .5	85 72	18/30 14/35
54-55	77	27 22	17 11	10 10	1 1	96 83	12/34 14/40
55-56	84	30 24	18 11	10 11	1.5 1	106 89	14/36 14/43
56-57	87	34 26	19 10	13 14	2 1.5	116 98	14/44 6/51
57-58	86	33	17	13	3.5	127	7/49

University of Wisconsin
Madison

year	courses given primarily for mathematics majors and math. graduates		courses given primarily for graduate and undergraduate students from other depts		Past enrollments in 100 level mathematics courses (except 111) over-all total for the 100 level courses (except 111)		
	number of students	number of courses	number of students	number of courses	number of students	number of courses	number of sections
46-47	60	5	70	3	130	8	
	70	7	10	1	80	8	
47-48	200	7	140	4	340	11	
	160	7	200	7	360	14	
48-49	260	6	140	4	400	10	16
	230	8	130	6	360	14	19
49-50	240	8	140	5	370	13	19
	200	9	150	7	360	16	21
50-51	190	9	110	6	300	15	18
	130	9	140	7	270	18	18
51-52	160	6	110	5	260	11	13
	140	7	140	7	280	14	15
52-53	120	5	80	3	210	8	10
	100	5	130	7	220	12	12
53-54	110	4	50	3	160	7	8
	110	5	90	4	200	9	9
54-55	110	4	80	5	190	9	10
	130	5	120	6	250	11	11
55-56	130	4	110	4	240	8	10
	150	5	150	6	290	11	12
56-57	220*	6	100	4	310	10	14
	220*	7	200	6	420	13	15
57-58	250*	9	180	5	430	14	19

First group

algebra 115a, b
analysis 120a,b and 112, 116, 119, 121
geometry 106, 108, 122 and 123

Second group

applied analysis 113a, b
(formerly 110 and 116b)
computing 131, 133
probability and statistics 118, 137
other courses: 104, 117, 138

*Includes 107

University of Wisconsin
Madison

Past enrollments in 200 level mathematics courses

year	courses given primarily for graduate stud. in mathematics		courses given primarily for graduate stud. in other depts.		over-all total for the 200 level courses*		
	number of students	number of courses	number of students	number of courses	number of students	number of courses	number of sections
40-41	60	5	40	2	100	7	
	50	5	40	3	90	8	
47-48	140	7	60	3	200	10	
	100	7	50	3	150	10	
48-49	140	8	60	2	210	10	12
	140	11	60	3	190	14	
49-50	150	8	40	3	190	11	
	150	11	30	2	180	13	
50-51	150	10	60	4	220	14	
	120	10	50	3	170	13	
51-52	130	9	50	3	180	12	
	120	10	30	3	150	13	
52-53	150	11	40	4	190	15	
	100	8	70	6	170	14	
53-54	140	10	10	1	150	11	
	90	8	50	6	130	14	
54-55	120	8	30	3	150	11	
	110	8	30	3	140	11	
55-56	100	7	120	5	220	12	
	100	9	60	2	160	11	
56-57	150	8	100	3	250	11	12
	120	8	70	3	190	11	
57-58	170	8	100	4	270	12	

First group

algebra 261; 246, 263, 264, 271, 272
analysis 220, 221; 202, 285, 286, 225, 272
foundations 230, 284
functional analysis 215, 216, 270, 275
topology 218, 223, 224; 219

Second group

diff. eq. and related 243, 244, 267, 268, 269
math. methods in phys. and eng. 213a, b and predecessors 265, 283
num. anal. and progr. 234, 235
prob. and statistics
various applied math.

*Reading course math. 200 counted only in enr. column

University of Wisconsin
Madison

History of teaching staff in mathematics

year	total enr. /100	total nr of sect.	sect. ta. by tea.asst	total sect. ta. by sen.st	senior staff: sect. ta.by prof.	sect. ta.by assoc.	sect. ta.by asst.pr	sect. ta. by instr.	sect. ta. by others
40-41	24	90*	30*	60*	9(3)*	5(2)*	6(2)*	36(9)*	4(2)*
	18	70*	10*	60*	9(3)*	5(2)*	6(2)	36(9)	4(2)
47-48	42				(* means estimated; 2 quiz sections = 1 regular section)				
	27								
48-49	32	146	97	49	8(4)	5(2)	23(8)	9(3)	4(2)
	23	122	72	50	10(4)	4(2)	24(8)	8(3)	4(2)
49-50	28	134	80	54	9(4)	5(2)	17(6)	20(5)	3(2)
	23	120	62	58	10(4)	7(3)	18(6)	18(5)	5(3)
50-51	25	130	79	51	16(6)	11(4)	16(6)	3(1)	5(3)
	20	101	55	47	15(6)	10(4)	16(6)	3(1)	3(3)
51-52	24	106	58	48	17(7)	9(3)	12(4)	6(2)	4(3)
	19	92	46	46	15(7)	9(3)	13(5)	6(2)	3(3)
52-53	26	113	66	47	22(9)	3(1)	12(4)	6(2)	4(3)
	22	96	51	45	19(8)	5(2)	12(4)	6(2)	3(2)
53-54	27	104	60	44	21(9)	4(2)	9(3)	6(2)	4(3)
	23	95	52	43	22(9)	5(2)	9(3)	6(2)	1(1)
54-55	31	117	77	40	19(8)	4(2)	9(3)	3(1)	5(3)
	26	105	60	45	20(9)	5(2)	9(3)	3(1)	8(4)
55-56	34	128	85	43	21(9)	3(1)	6(2)	5(2)	8(6)
	28	112	69	43	21(9)	3(1)	6(2)	5(2)	8(6)
56-57	39	143	97	46	18(8)	3(1)	6(2)	10(4)	9(6)
	32	125	85	40	14(7)	- -	6(2)	10(4)	10(7)
57-58	40	157	112	45	15(8)	4(2)	6(2)	13(5)	7(4)

second column: total enrollment in mathematics courses divided by 100, listed for each semester separately

third column: total number of sections taught in a given semester. Note that this total sometimes differs by 1 or 2 from the total obtained from pages 11 -13. The figures above are more reliable.

fourth column: total number of sections taught by teaching assistants in a given semester

fifth column: total number of sections taught by "senior staff", that is, teachers who are not teaching assistants

the last five columns show the composition of the senior staff: full professors, associate professors, assistant professors, regular instructors and "others". The others include visiting professors and lecturers, and university staff with their major appointment outside the mathematics department

numbers in parentheses denote the number of teachers in each category

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Future enrollments in elementary mathematics courses

Total L. & S. mathematics below Math. 100

year	total undergrad. stud. in L. & S. /100	total stud. elem. math. /100	total stud. in calculus /100	total stud. other courses /100
60-61	70	20 16	5 5	15 11
65-66	90	26 21	6.5 6.5	19.5 14.5
70-71	115	34 28	8 8	26 20

Assumptions: The total first semester enrollment of L. & S. undergraduates (referred to as LS below) will increase as indicated; these figures are based on projections made by Dr. L. J. Lins for 61-62 and 66-67;
The total enrollment per academic year in calculus which has increased from 7 percent to more than 10 percent of LS during the last five years will continue a rapid increase to perhaps 14 percent;
The total enrollment per academic year in other courses below Math. 100 which has increased from 30 percent to 35 percent of LS will continue a slow increase to perhaps 40 percent in 1970;
The distribution of the academic year enrollment over the first and second semester will remain as during the past few years.

Total Engineering mathematics up to Math. 111

year	total undergrad. stud. in Eng. /100	total stud. elem. math. /100	total in pre-calc. /100	total in calculus /100	total in diff. eq. 111 /100
60-61	37	25 19	5 1	16 15	4 3
65-66	52	34 27	7 1.5	21.5 20.5	5.5 4.5
70-71	70	44 35	9 2	28 27	8 6

Assumptions: The total first semester enrollment of Engineering undergraduates (referred to as E below) will increase as indicated (data by Dr. Lins as above);
The total enrollment per academic year in calculus which has been 75 percent of E during the last five years will increase to 80 percent when the students start with calculus right when they enter school (new plan effecti.e Sept. 1959) 50 percent of the entering freshmen in Engineering will start with Math. 60 (calculus) while 50 percent will start with Math. 6 (pre-calculus);
At precent the number of students in Math. 111 is equal to 75 percent of the number of engineering students who were in their last semester of calculus during the preceding semester - it is expected that this percentage will go up to at least 90 percent. This estimate takes care of a certain number of L. & S. students who take Math. 111.

Predicted enrollments in elementary mathematics

year	over-all total elem. math. /100	total math. below 100 except calc.	total in calc.	total in diff. eq.
57-58, I	33	17	13	3.5
56-57, II	26	10	14	1.5
60-61	45	20	21	4
	35	12	20	3
65-66	60	26.5	28	5.5
	48	16	27	4.5
70-71	79	35	36	8
	63	22	35	6

During the last six years the situation with regard to elementary mathematics has deteriorated to a point where practically no mathematics below differential equations is taught by senior staff. This means that students who take less than five semesters of mathematics never see a senior staff member in their mathematics courses ! The following plans will improve this situation.

Two plans to teach the elementary mathematics courses.

Plan A. We use sections of an average of 25 students in all courses. The courses below calculus will be taught by teaching assistants as at present. 50 percent of the calculus will be taught by senior staff, and all differential equations Math. 111 will be taught by senior staff. (1951-54 situation).

Plan B. Sections of 25 students are used only below calculus; these sections are taught by teaching assistants. All calculus and differential equations will be taught on a lecture - discussion basis as follows. Senior staff lectures to groups of 80 to 150 (average 100), 3 hours per week in calculus and 2 hours in differential equations 111. In addition teaching assistants lead discussion sections of 25 students each, meeting 2 hours per week.

	Plan A		Plan B	
year	teaching asst. sections	senior staff 3, 4 and 5 hr sections	teaching asst. sections (in 4 or 5 hr units)	senior staff 2 and 3 hour lectures
57-58, I	94*	40*	100*	16*
56-57, II	68*	34*	71*	16*
60-61	120	60	130	25
	90	50	95	23
65-66	160	80	170	33
	120	70	125	31
70-71	210	105	230	44
	160	95	170	41

*These are hypothetical figures indicating what plan A or B would mean if they would now be in effect. For comparison note that in 1957-58, I there

Predicted enrollments in 100 level mathematics (except Math. 111)

year	total undergrad. stud. in L. & S. /100	total grad. stud. in Eng. /100	total stud. 100 level math. /100	total in courses primarily for math. students	total in courses primarily for non-math. students
60-61	70	5.5	6 6.5	3.5 3.5	2.5 3
65-66	90	8.5	8.5 9	4.5 4.5	4 4.5
70-71	115	12	11.5 12.5	6 6	5.5 6.5

Assumptions:

The total first semester enrollments of L. & S. undergraduates and Engineering graduates (referred to as LS and EG below) will increase as indicated. The above LS, EG figures are based on data for 61-62 and 66-67 supplied by Dr. Lins.

In 1940 the total enrollment for the academic year in the 100 level courses for math. students was 2 percent of LS. After world war II the percentage jumped to 5 percent and it is higher than 8 percent during the present year. It is expected that the percentage will go up to 10 percent, partly because more engineering students will enroll in courses such as Advanced Calculus and Determinants and Matrices in the future.

During the past five years the total enrollment per academic year in the 100 level courses for non-mathematics students has been very close to the academic year enrollment in Math. 111. The figure was also quite close to the number EG. It is to be expected that the Math. 111 figure will go up faster than EG (page 15). It seems reasonable to put the figure in the last column between Math. 111 and EG (the actual figure used in the table is just EG).

The distribution of the predicted academic year enrollments over the first and second semester has been taken as in the past, with a correction for the new elementary mathematics plan in Engineering.

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actually are 127 sections of elementary mathematics of which 111 are taught by teaching assistants and 16 by senior staff. Of the latter 16, the 9 sections in differential equations Math. 111 have a total enrollment of 350.

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The future teaching of the 100 level math. courses (except Math. 111)

In order to keep all sections smaller than 30 or 35 students it has been necessary in the past to work with an average size of no more than 22 students.** However, as enrollments go up there will be fewer small classes at the 100 level and it may be quite feasible to work with an average of 25 students per section.

In the future there may be some advantages in using a lecture - discussion system (as considered on page 16) in some of the courses with large enrollments. Accordingly two plans have been worked out.

Plan A. The teaching will be done entirely by senior staff as in the past.

Plan B. Most of the courses which are taught primarily for non-mathematics students will be taught on a lecture - discussion basis as follows: senior staff lectures to groups of 60 to 100 students, meeting 2 hours per week; in addition teaching assistants lead discussion and problem sections of about 25 students each, meeting 2 hours per week.

The teaching of the 100 level math. courses (except 111)

year	total enrollment	Plan A: senior staff sections	Plan B: senior staff sections	Plan B: senior staff 2 hr lecture sections	Plan B: tea. asst. sections (4 hr units)
57-58, I 56-57, II	430 420	19* 15*	not feasible		
60-61	600 650	24 26	17 18	3 3	4 5
65-66	850 900	34 36	19 20	6 6	8 9
70-71	1150 1250	46 50	25 26	7 8	11 12

*These are the actual figures

**In 1957-58, I there are 19 sections averaging 23 students. Nevertheless one of the 19 sections (one in Math. 113a) has 50 students.

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Future enrollments in 200 level math. courses

Predicted enrollments in 200 level mathematics

year	total grad. stud. in L. & S. /100	total grad stud. in Eng. /100	total stud. 200 level mathematics /100	total in courses primarily for math. students	total in courses primarily for non-math. students
60-61	20	5.5	3.5 3	200 160	150* 130*
65-66	22	8.5	4.5 3.5	225 175	225* 175*
70-71	24	12	5.5 4	250 200	325* 275*

Assumptions: The total enrollments of L. & S. graduates and Engineering graduates (referred to as LSG and EG below) will increase as indicated. The above LSG and EG figures are based on data for 61-62 and 66-67 supplied by Dr. Lins.

In all but two or three of the last ten years the total enrollment per academic year in the 200 level courses for math. students was 18 percent of the number LSG. The same percentage has been taken for the future. It is possible that the percentage will rise to 20 percent, say - this because more non-math. students may enroll in the courses for math. students.

During the past ten years the total enrollment per academic year in the 200 level courses for non-mathematics students has varied a great deal. Expressed as a percentage of EG it seems the percentage went up whenever well-qualified people in the mathematics department taught the right kind of courses for the group, while the percentage went down in other years.** During the past three years the percentage has been constant at 50 percent. It seems doubtful if the percentage will remain as high as 50 percent in the future. Much will depend on the ability of the Math. Dept. of offer courses with the proper emphasis and on the possibility of acquiring the proper staff.

In connection with the problem of math. courses for non-math. students it is interesting to look at the picture for 57-58, I (compare page 15). At the beginning of the semester the announced course Math. 201 was dropped for lack of staff (not for lack of students). Another course (Math. 211) has 60 students, and this group is really too large to be taught in a single section.

*These predicted enrollments will be realized only if the Math. Dept. will provide suitable courses.

**Not all, not even a majority, of the students in the courses primarily for non-math. students are from engineering - many are from physics, chemistry and other fields. It is believed, however, that the trend in these courses may follow the trend in the number EG. This is the motivation for using percentages of EG.

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The future teaching of the 200 level math. courses

It seems desirable to keep all sections smaller than 30 to 35 students. For that reason it will be necessary to work with an average size of no more than 20 students per section, at least until considerably larger enrollments make an increase in the average possible. By 1970 an average of 23 to 25 students may be feasible. The average number of students per section during the last five years was 16 - and this includes the enrollment in the reading course Math. 200 without counting Math. 200 as a course.

One or two courses (notably Math. 213a and b) may get such large enrollments in the future that it becomes feasible to offer them on a lecture - discussion basis: 3 lectures per week given by a senior staff member, lecturing to the whole group, and discussion sections of at most 25 students meeting once a week under the direction of qualified teaching assistants. However, it is unlikely that such a system would be used extensively at the 200 level before 1970.

The teaching of the 200 level math. courses

year	total enrollment	total sections	sections taught primarily for math. students	sections taught primarily for non-math. students
57-58, I	270*	12*	8*	4*
56-57, II	190*	11*	8*	3*
60-61	350	18	10	8
	300	16	9	7
65-66	450	22	11	11
	350	18	9	9
70-71	550	24	11	13
	500	22	10	12

*These are the actual figures